NATIONAL BUREAU OF STANDARDS

January/1969

Technical News Bulletin

U.S. DEPARTMENT OF COMMERCE

The Nonmetric World . . .

NBS Begins Metric Study

The major countries[1] in the nonmetric world are few in number: the United States, Canada, Australia, and New Zealand; and this list is likely to become smaller in the future. Australia has recently completed a study which recommended conversion to the metric system, and it is likely that any such move would have a great deal of influence on New Zealand.

The United States is not letting these events pass unnoticed or without action. On August 9, 1968, the President signed into law a bill providing a three-year metric study. It authorizes the Secretary of Commerce to

> "conduct a program of investigation, research, and survey to determine the impact of increasing worldwide use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting by international use of dimensional and other engineering standards based on the customary measurement units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States."

The Secretary has assigned responsibility for the study to NBS where a small group, headed by A. G. McNish, Assistant to the Director, has begun planning the study and conducting exploratory investigations. Because of limited funds, the metric study will continue in the planning and pilot phase for the time being.

The objectives during the planning phase are to identify major problems, specify tasks for studying problems, evaluate relative priorities, and experiment with methods of undertaking identified tasks. A full-scale study is being planned for fiscal years 1970 and 1971.

Readers interested in learning more about the metric system may refer to the chart of the modernized metric system, which appears as this issue's centerfold.

[1] Other nonmetric countries include Sierra Leone, Rhodesia, Burma, British Honduras, Guyana, Liberia, Nigeria, Kenya, Uganda, South Arabia, and Malaysia.

NATIONAL BUREAU OF STANDARDS

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U.S. DEPARTMENT OF COMMERCE
C. R. Smith, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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SPECIAL INSERT

A full-color reproduction of the new metric wall chart prepared by NBS is the centerfold of this issue of the Technical News Bulletin. The centerfold is one-third the size of the wall chart designed for classroom and laboratory use, and provides in a more convenient size a handy reference for students and professionals alike. Both the large wall chart, NBS Special Publication 304 (50 cents), and the small chart, NBS Special Publication 304A (20 cents), may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated. For orders of 100 or more, the price is reduced 25 percent.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research

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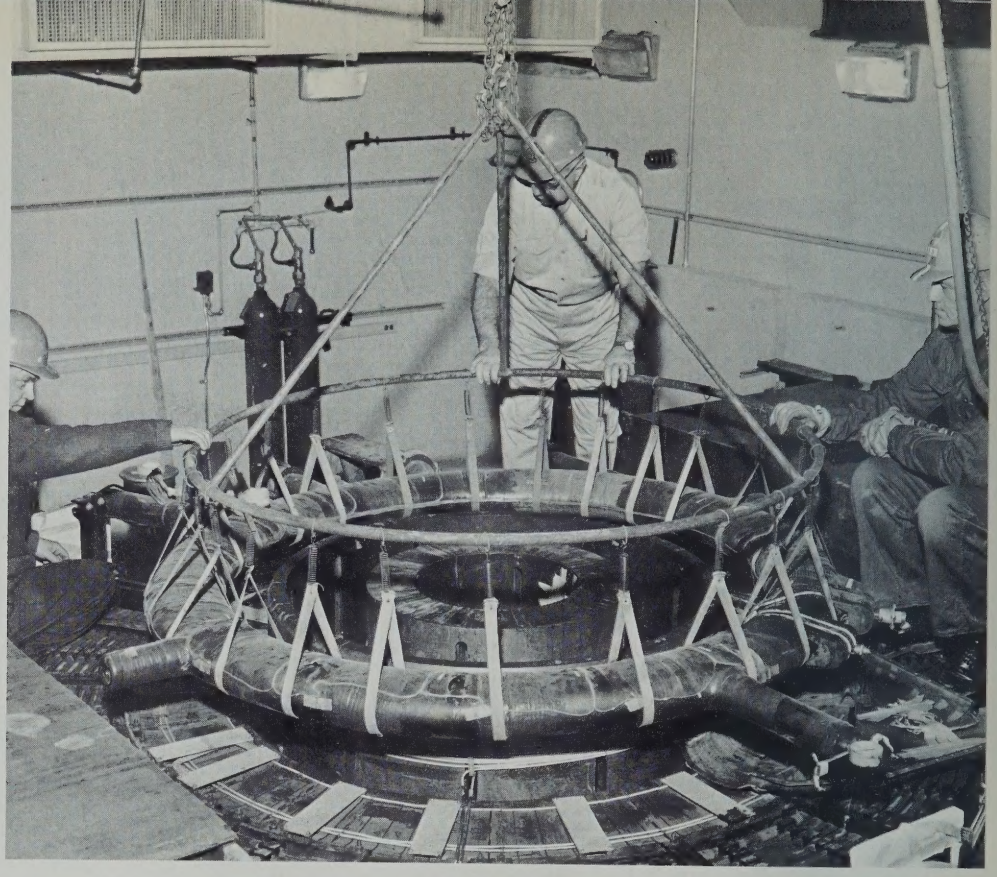


Alex Filipovich (left) and Millard A. Cook (center) help Otto E. Spokas aline the donut on top of the lower circular pole portion of the electromagnet.

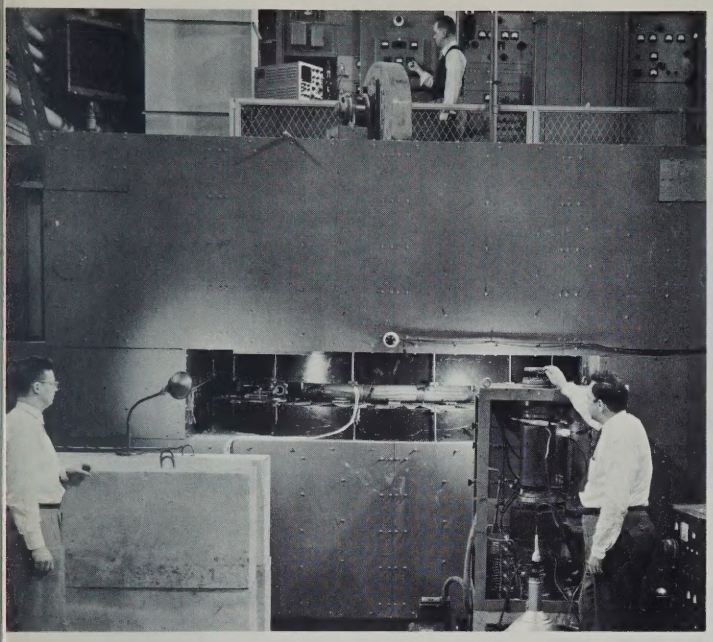
NBS Installs SYNCHROTRON *at Gaithersburg Laboratories*

THE LAST OF THE HIGH-ENERGY particle accelerators planned for the new NBS Center for Radiation Research has now been installed and is in operation at the Bureau's Gaithersburg (Md.) site. This device, a 180 million-electron-volt electron synchrotron, was recently moved from the Bureau's old Washington (D.C.) grounds to the new 565-acre laboratory complex.

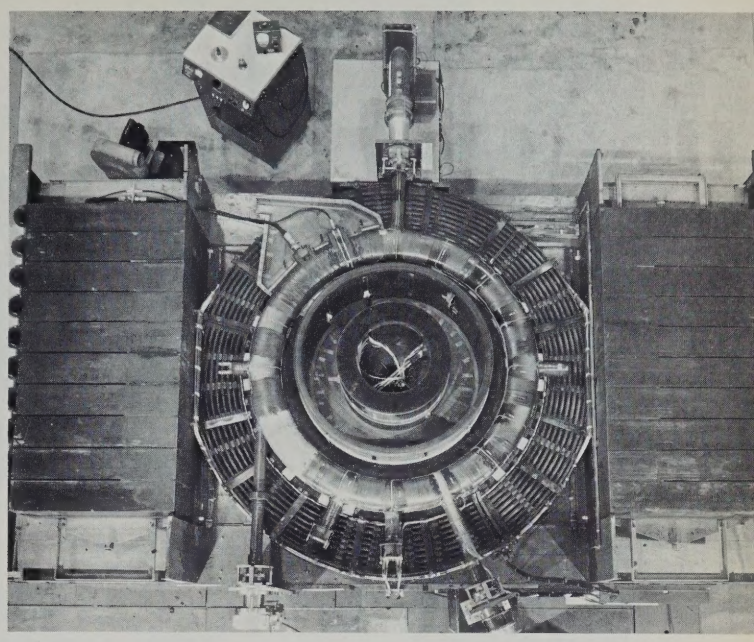
The synchrotron is operated for users by the Center for Radiation Research. Initial experimental work with the synchrotron will be primarily under the direction of the Center. The Far Ultraviolet Physics Section of the Atomic Physics Division will be using the synchrotron as a unique source of far ultraviolet radiation in analyzing gas-absorption spectra and in studying the optical and photo-electric properties of solids.

The NBS synchrotron, a modification of a small betatron electron accelerator, was first activated in 1953. For many years it provided basic x-ray data essential to the safe and effective utilization of radiations from high-energy electron accelerators in medical treatment, industrial radiography, and nuclear physics research.[1] Then in 1960 scientists of the Atomic Physics Division suggested that the synchrotron had value as a source of far ultraviolet light. This radiation is produced by the deceleration of electrons and is extracted as a confined cone of light in the direction of the electron velocity. In 1961, a tangential port was added to the donut of the machine for this purpose by the Radiation Physics Division. Since that time a major emphasis has been placed on the use of the machine as a far ultraviolet source. Pioneer developments by NBS scientists yielded the discovery of many highly excited atomic states in the noble gases—due to the excitation of inner electrons or to the excitation of two electrons simultaneously.[2] These discoveries have stimulated a great deal of new activity, both experimental and theoretical, in this field.

Following the NBS studies, two other major synchrotrons (one in Hamburg, Germany, and the other in Tokyo,



The synchrotron at the old NBS campus in Washington, D.C. John McElhinney (left), Alex Filipovich (above), and James E. Leiss inspect the equipment. A section of the donut and the two circular pole portions of the electromagnet are visible at center.



A top view of the synchrotron shows the donut and its ports. The electrons are injected by an electron gun in the port at bottom center. The air-cooled resonant cavity (upper left-hand quadrant) provides the radiofrequency field. The far ultraviolet radiation is emitted through the tangential port (lower left). Two ports (top center and lower right) are connected to vacuum equipment.

Japan) were also adapted for the extraction of the uv light. The additional laboratory facilities at the machine's new location make possible an increase in uv light beam ports—from one port at the old site, to four at the new complex—for the attachment of experimental equipment. Three of the ports planned for use by the Far Ultraviolet Physics Section are provided with new spectrometers especially adapted for a variety of experiments. The fourth port will, at all times, be available to guest scientists. This port will be made available on a scheduled basis to insure the widest variety and greatest efficiency of experimental uses.

Present installation of the synchrotron consummated a year of work by engineers and technicians who reduced the machine to its minimal parts and then, with great care, moved them 21 miles to their new home. First the control console, electronic instrumentation, and vacuum equipment were moved. Next to arrive were the largest pieces of equipment—two halves of an electromagnet, together weighing 150 tons.

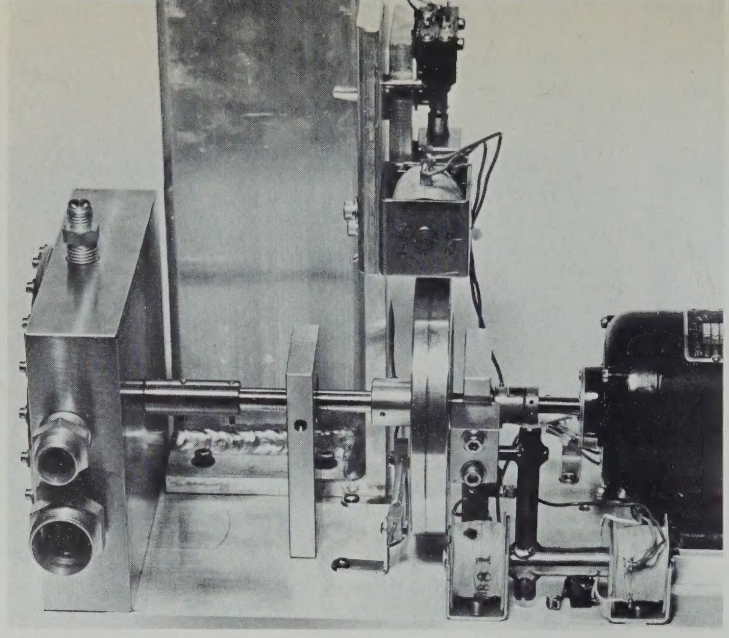
The most difficult and hazardous task was the movement of the "donut," a hollow glass toroid in which the electrons are accelerated. The donut is assembled from several glass sectors held together with glass tape, sealed with filler varnish, and evacuated. For moving, the evacuated donut was crated, cushioned, and handled with great care. Lifting and alining the donut were accomplished by suspending it from a circular metal frame attached to a traveling hoist; thus a constant external pressure could be maintained on the donut during movement.

When assembled, the donut is sandwiched between the two circular pole portions of the large electromagnet, one pole above the ring and one below it. The electromagnet also extends above, below, and on two sides of the circular pole pieces.

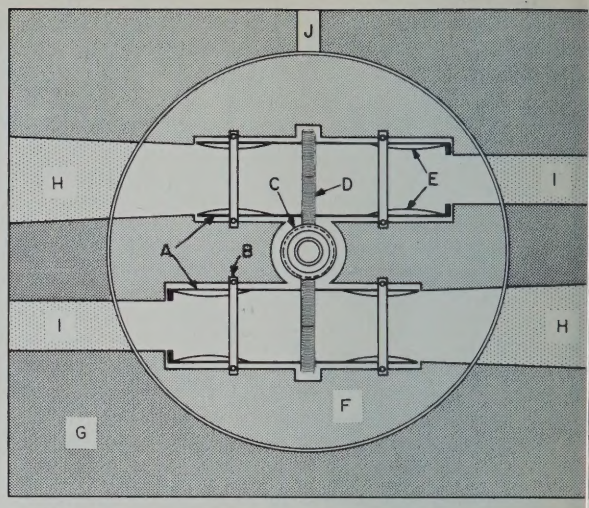
The acceleration of electrons in the synchrotron's donut is accomplished in three steps. First an electron gun injects 60-hertz pulses of electrons into an increasing electromagnetic field. Second, betatron action accelerates them up to an electron energy of 2 MeV. At this point the synchrotron action begins. The additional acceleration—from 2 to 180 MeV—is then given the electrons by an oscillating tangential electric field which is applied at one point of their circular orbit in synchronism with the orbital motion. The average accelerated electron beam current in the synchrotron is 2×10^{-8} A. It is hoped in the future to increase this current by a factor of one hundred using a small linear accelerator as an injector.

[1] Research in high-energy x-rays provides data for nuclear physics, medicine, and industry, Tech. News Bull. 38, No. 12, 173 (Dec. 1954).

[2] Madden, R. P., and Codling, K., New autoionizing atomic energy levels in He, Ne, and Ar, Phys. Rev. Letters 10, 516 (1963).



In this view of the rotating assembly, the sample container housing is at far left. Sample containers are inserted pneumatically into the larger fitting on the housing, the smaller fitting is for return air.



Schematic of the dual sample-biaxial rotating assembly: A, rotating cylinders; B, cylinder bearings; C, stationary worm; D, worm gear; E, sample retainer springs; F, rotor; G, rotor housing; H, sample inlet; and I, return air inlet.

IMPROVED ACCURACY IN NEUTRON ACTIVATION ANALYSIS

Oxygen in steel determined rapidly by new procedures

The Value of Neutron activation analysis as a nondestructive analytical tool has been increased markedly by recent work at the National Bureau of Standards. A tenfold increase in accuracy and precision has been achieved by use of a new sample-irradiation system [1] together with a procedure for evaluating and correcting for systematic errors.[2]

S. S. Nargolwalla, M. R. Crambes, and J. R. DeVoe of the NBS Institute for Materials Research devised the improved technique, and established its accuracy and precision by comparing the measured oxygen contents of three standard reference materials with their certified values. Since then, the method has been used to determine: The total elemental analysis of oxygen, nitrogen, phosphorus, and sulfur in biological materials such as protein; silicon in borosilicate glass and silicon carbide and the metallic components of various metallo-organic standards. At present, the possibility of determining halogens in silver bromide photographic emulsions is being investigated.

In general, neutron activation analysis uses high-energy neutrons to irradiate an element in some material, causing that element to change from its normal state to a radioactive state. Once radioactive, the material begins to revert to its normal state by emitting various radiations (typically high-energy gamma photons). These radiations are monitored and the amount of radiation emitted is indicative of the amount of the element present in the material being studied. In the case of oxygen, for example, such neutron irradiation activates the oxygen in a sample material to produce radioactive nitrogen, which decays rapidly, emitting high-energy gamma photons.

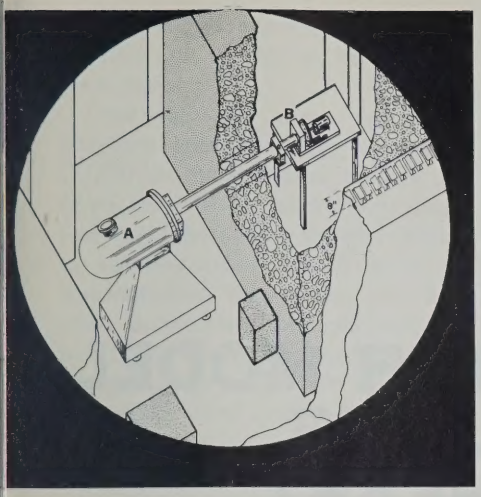
To determine the oxygen content of a material, a sample of the material and a standard material of known oxygen content are irradiated simultaneously. The gamma energy emitted from the materials is counted and the oxygen content of the sample is calculated by comparing its gamma emission to that of the standard. Unfortunately, the results of this technique may be adversely affected by systematic errors as well as instability of the neutron beam.

The NBS improvements to the technique avoid these possible sources of error. This is done by providing identical irradiation and counting environments for the sample and standard materials, and by evaluating, and cor-

Table 1. *Oxygen in ferrous materials (ppm)*

NBS No.	Vacuum fusion			Neutron activation			Inert gas fusion		
	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n
1090	484	14	216	492	13	36	497	13	12
1091	131	8	286	132	2	36	129	8	11
1092	28	2	105	28	1.2	42	29	5	20

$\bar{x}$= mean value in parts per million (ppm).
s= standard deviation of a single determination.
n= number of determinations.



The high energy neutrons produced by the 14 MeV generator (A) are fed through the wall (left) to irradiate samples in the rotating assembly (B).

and the ratio of sample counts to standard counts was determined.

To correct for any systematic errors, the same procedure was followed for two identical standards. The count ratio of these standards was used as a correction factor in determining the oxygen content of the sample. Correction factors for both neutron and gamma attenuation were used to give an accurate oxygen content of the sample.

Using this technique, the oxygen content of three steel standards, NBS Nos. 1090, 1091, and 1092, was determined. The values obtained by the neutron activation analysis technique were compared with the certified oxygen content of the steels as determined by vacuum and inert gas fusion techniques (Table 1). It appears that the precision of this technique is controlled almost entirely by the random error calculated from counting statistics.

[1] Lundgren, F. A., and Nargolwalla, S. S., Use of a dual sample-biaxial rotating assembly with a pneumatic tube transfer system for high precision 14-MeV neutron activation analysis, Anal. Chem. 40, No. 4, 672–677 (Apr. 1968).

[2] Nargolwalla, S. S., Crambes, M. R., and DeVoe, J. R., A technique for the evaluation of systematic errors in the activation analysis for oxygen with 14-MeV neutrons, Anal. Chem. 40, No. 4, 666–671 (Apr. 1968).

recting for, neutron and gamma attenuation during irradiation and counting.

Identical irradiation is made possible by a dual-sample biaxial rotating assembly. This assembly holds two irradiation capsules, and is so designed that the capsules are turned both axially and rotationally about a drive shaft. This double-turning motion ensures that both capsules are irradiated identically.

In the first use of the improved technique the oxygen contents of three NBS steel standards were determined. Of critical importance to the analytical results was the preparation and handling of the materials. To prevent oxygen contamination, the samples were carefully prepared in a nitrogen atmosphere before being placed in the irradiation capsules, which were also made in a nitrogen atmosphere. Nitrogen was again used in both the irradiation chamber and the pneumatic system that transports the capsules to the irradiation chamber, which houses the rotating assembly, and to the counting device.

After irradiation, the gamma energy emitted by both the sample and standard was counted and integrated,

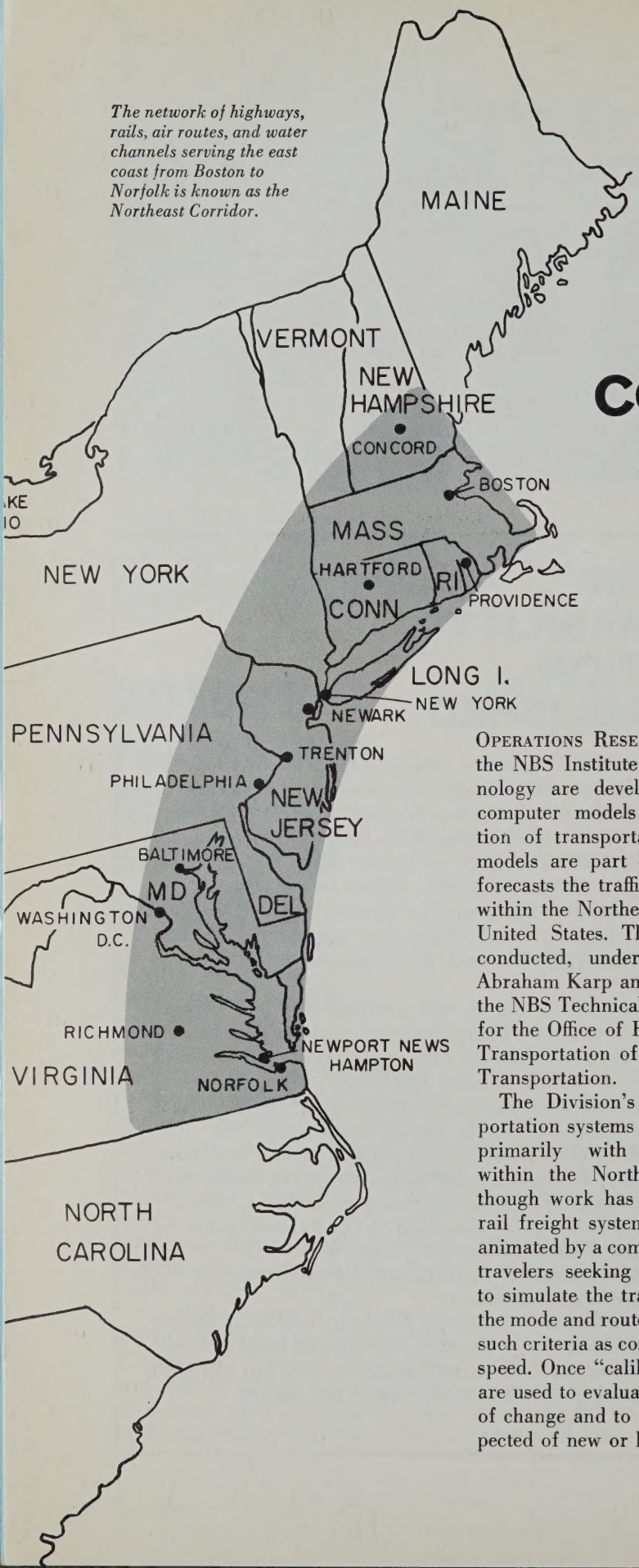
FABRIC FLAMMABILITY SECTION ESTABLISHED

To Implement the Recently Enacted amendments to the Flammable Fabrics Act, NBS has established a Fabrics Flammability Section within the Product Evaluation Division, Institute for Applied Technology. The new section is headed by James V. Ryan and will carry out responsibilities assigned to the Secretary of Commerce. During 1967, as a Commerce Science Fellow in the Office of the Assistant Secretary of Commerce for Science and Technology, Mr. Ryan had primary responsibility for preparing both new flammable fabrics legislation and Departmental support for its enactment.

The Flammable Fabrics Act of 1953 provided only for interstate commerce control of certain highly flammable clothing fabrics. The amendments, enacted in December 1967, extend the law to cover all wearing apparel as well as interior furnishings. The amendments authorize the Secretary of Commerce to set standards and regulations when "needed to protect the public against unreasonable risk." The research and data gathered by the Section will help in these determinations of need and will form the basis for standards and regulations.

The implementation of the law requires a capability to measure those characteristics of products, fabrics, and related materials that are hazardous because of their flammability characteristics. It is the development of the techniques for making such measurements that will primarily concern the new laboratory.

In addition, the Section will conduct feasibility studies on the reduction of the flammability of products, fabrics, and materials; will develop flammability test methods and testing devices; and will offer appropriate training in the use of these methods and devices.



The network of highways, rails, air routes, and water channels serving the east coast from Boston to Norfolk is known as the Northeast Corridor.

COMPUTER MODEL SIMULATES NORTHEAST CORRIDOR

Bureau Aids Transportation System Planners

Operations Research Analysts of the NBS Institute for Applied Technology are developing a series of computer models simulating operation of transportation systems. The models are part of a system which forecasts the traffic demands of 1980 within the Northeast Corridor of the United States. This study is being conducted, under the direction of Abraham Karp and Louis Santone of the NBS Technical Analysis Division, for the Office of High Speed Ground Transportation of the Department of Transportation.

The Division's analysis of transportation systems has been concerned primarily with passenger travel within the Northeast Corridor, although work has also been done on rail freight systems. The models are animated by a computer to "generate" travelers seeking transportation and to simulate the traveler's selection of the mode and route of travel, based on such criteria as cost, convenience, and speed. Once "calibrated," the models are used to evaluate the consequences of change and to forecast the use expected of new or hypothesized modes experimentally inserted into the models.

The Northeast Corridor

The Northeast Corridor is a 500-mile strip of land along the Atlantic coast, stretching from southern New Hampshire to Norfolk, Va. It is densely populated, containing over a fifth of the country's population in less than 2 percent of its area.

By 1980, it is estimated, the Corridor will have grown to nearly 1½ times its 1960 population. Results of this change will be reflected both in burgeoning cities and in new satellite communities. This will produce more commuting and pleasure travel, in addition to a greater flow of commerce. The new demands will necessitate more efficient operation of present transportation and the introduction of new capabilities. Anticipating this, the Department of Commerce established the Northeast Corridor Transportation Project in 1964 and assigned NBS, among others, to perform research on the transportation needs of 1980. With the establishment of the Department of Transporta-

tion in 1967, responsibility for the Project was transferred to the new Department.

Over the past three years, the Bureau has developed a series of seven CORRidor mathematical models. All seven versions are concerned, essentially, with how many travelers desire to use the system, which modes of transportation they select, and how many people travel between each city pair in the Corridor by each mode on any given day. The only difference among the seven models is degree of sophistication and refinement in the transportation systems they represent.

Generation of Travelers

One of the essential tasks of the model is to "generate" travelers—create hypothetical people seeking transportation between the cities of each origin-destination pair. The model then performs a "modal split" on the travelers, assigning each to one of the available transportation modes—bus or auto, for instance.

The model must be able to meet the needs of the travelers generated; calling off a trip because all service offered is too slow may be realistic, but is of no help in evaluating system operation. The definitions required for each origin-destination pair include specification of: service frequency, transfer possibilities, passenger cost, and time spent in travel—all factors affecting passenger choice.

Impedance Functions

"Impedance functions" contained in the model play a significant role in causing the traveler to select or reject a route or mode. Impedance functions consider total travel time, travel cost, discomfort, and frequency of service.

Each mode of transportation incorporated in the model must be simulated realistically in order to correctly establish its impedance values. At present, only four modes account for all transportation—bus, train, and airplane are the scheduled carriers, and the automobile is the sole nonscheduled one. The CORR models are programed to accommodate seven transportation modes simultaneously. This makes it possible to evaluate changes in both present modes and hypothesized future modes.

Use of a mode requires that link costs, a timetable for future links, and link times for it be specified in the model. These are evaluated to produce the impedance values for the travel functions. The impedance functions are first "processed through" an algorithm to weed out trips that are unreasonable on the basis of time, cost, and frequency; raw data for 100 000 possible trips per day may be condensed to as few as 1500 "reasonable" trips.

In real life, the travel impedance values define the traveler's selection; in the model they determine demand—the volume of travelers seeking to use each mode for each trip. Different versions of the model treat this in two ways. In one the travelers are generated specifically for each mode; in the other the travelers are generated in one program and the modal split performed in another.

In preparing data for the models it quickly became obvious that there would have to be some compromise between the depth of detail considered in the model and the amount of computer storage required by it. The fineness-storage reciprocity was resolved by dividing the Northeast Corridor into 29 superdistricts, most of them representing a large city and the surrounding counties. This greatly reduced the number of origin and destination points; each trip now begins and ends at carrier terminals or at superdistrict central points. However, the corridor may also be divided into 131 districts, most of which correspond to counties. One version of the model is operative at this level of areal aggregation.

In real transportation systems travelers depart and arrive at every minute of the day and night. However, due to scheduling constraints, movement for those travelers on common carriers occurs every 15 minutes. Travelers on the auto mode may enter the system as frequently as once a minute. These timed link entries provide for travelers entering, traversing, and leaving the individual links. The day is broken not only into timed link entries, but in addition into five time intervals simulating peak and off-peak conditions that affect routing times. Five different values may therefore be required for each impedance function.

New Modes

When the model is first placed in operation it is "calibrated" by comparing the number of hypothetical travelers with actual counts obtained for each present mode-trip combination. Malfunctions identified thereby can be corrected or compensated for. Once realistic operation is approximated, the model will be ready for predicting future volumes and the consequences of changes.

Incorporating a new mode requires that raw schedule data be inserted, impedance values obtained, and the demand generated; only then can the modal split be obtained. In real life, schedules are adjusted to the demand experienced, but neither can be known with certainty for a previously unused mode. Even a hypothetical mode can be analyzed, however, by

continued on page 20

Martin Aronoff and Louis Santone examine computer printout that predicts how much traffic will be carried by a proposed new highway link.

NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System, which was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the NBS Office of Standard Reference Data.

Electron Impact Excitation of Atoms

NSRDS–NBS 25, *Electron Impact Excitation of Atoms* [1] (116 pp.; $2), by B. L. Moiseiwitsch of The Queen's University of Belfast and S. J. Smith of the NBS Laboratory Astrophysics Division, is a critical review of the experimental and theoretical literature on the excitation of atoms by electron impact. In the first part of the review, theoretical aspects are considered. The atoms are examined in the order of increasing complexity, beginning with atomic hydrogen and then, in turn, helium, the heavier inert gases, mercury, cadmium, and zinc, the alkali metals, oxygen, and nitrogen, as well as certain positive ions.

This review discusses and intercompares the theoretical methods ranging from the Bethe and Born approximations to the close coupling approximations. Further, where possible, on theoretical grounds or through intercomparison, it discusses the reliability of the various methods. A general critique of the optical method of measuring excitation functions is provided with the objective of promoting higher quality future experimental work. The critical examination of existing experimental work led the reviewers to conclude that most workers have ignored important physical and instrumental effects and to presume that the data in the literature are subject to many unrecognized systematic errors.

NSRDS–NBS 25 was first published in the April 1968 issue of *Reviews of Modern Physics,* Vol. 46, No. 2, as it provided the most effective and immediate dissemination channel. Because the publication policy of NSRDS is to make use of all available channels of publication and dissemination, and because the need for a wider audience and a continuing source of supply was recognized, the review was also published in the NSRDS series.

Standard X-Ray Diffraction Powder Patterns

NBS Monograph 25—Section 6, *Standard X-Ray Diffraction Powder Patterns* [1] (95 pp.; 60 cents), by Howard E. Swanson, Howard F. McMurdie, Marlene C. Morris, and Eloise H. Evans, presents patterns for 60 substances. Fifty-four of these patterns represent experimental data and 6 are calculated. The experimental x-ray powder diffraction patterns are made with a Geiger counter x-ray diffractometer, using high purity samples. All d-values were assigned Miller indices determined by comparison with theoretical interplanar spacings and from consideration of space group extinctions. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible. The calculated x-ray powder diffraction patterns were obtained from published crystal structure data. The reported peak height intensities for calculated patterns were converted from integrated intensities. Reference intensity values based on the strongest line of corundum(113) in a 50 weight percent mixture are given for 98 materials.

In the past ten years there has been a large increase in the application of x-ray powder diffraction analysis to a wide variety of fields. X-ray powder diffraction patterns are used to identify unknown crystalline materials by matching d-spacings and intensity measurements. As a powerful tool for the nondestructive qualitative identification of compounds, a file of standard x-ray powder patterns is required for comparison purposes.

To supply this need, close to 10 000 reference patterns have been compiled as the X-Ray Powder Diffraction File. This File has been gathered from many sources and was produced under the auspices of the Joint Committee on Powder Diffraction Standards. The Committee is sponsored jointly by the American Society for Testing and Materials, the American Crystallographic Association, the (British) Institute of Physics, and the National Association of Corrosion Engineers. Financial support for some of the experimental work is provided by NBS. Under the partial sponsorship of the Joint Committee, a program at the Bureau contributes new data, and aids in the evaluation

and revision of published x-ray data and in the development of diffraction techniques.

A high degree of accuracy has been possible in the NBS measurements through the use of internal standards of silver or tungsten. The lattice constants of these two basic standards were redetermined in 1966 [2] (see Sec. 4 of NBS Mono. 25) so that these values are now well established. To date the Bureau has contributed over 800 reference patterns. The most recent of these are included in Section 6 of NBS Mono. 25, the sixteenth in the series of compilations of Standard X-Ray Diffraction Powder Patterns.

Atomic Data

A compilation journal to cover the fields of atomic and molecular physics, *Atomic Data,* is being planned for initial publication in 1969 by Academic Press, Inc. It will be similar in style to *Nuclear Data,* which covers the area of nuclear structure physics. Katharine Way, who is also editor of *Nuclear Data,* will serve as editor of the new journal; C. F. Barnett, Director of the Atomic and Molecular Processes Information Center, and L. J. Kieffer, Director of the JILA Information Center, are serving as associate editors.

The aim of a compilation journal is to present collections of experimental data and tables of theoretical values. The former are essential first steps in the distillation of scientific information, the latter indispensable tools for testing the relation of theory to experiment. At present, these two types of data collections are often published as reports, which are difficult to find and cumbersome to use. *Nuclear Data* has shown that a carefully edited and refereed journal in an appropriate field can successfully present them to a worldwide audience in an accessible and readable form. Correspondence on potential manuscripts for *Atomic Data* should be sent to Katharine Way, Editor, Atomic Data, Department of Physics, Duke University, Durham, N.C. 27706, or to either of the associate editors.

Reform—Manipulating Formatted Data Files

NBS Technical Note 444, *Reform: A General Purpose Program for Manipulating Formatted Data Files* [1] (25 pp.; 40 cents), by Robert C. McClenon and Joseph Hilsenrath, describes one of a series of computer programs being developed by the NBS Office of Standard Reference Data to assist the data centers affiliated with NSRDS.

A large number of data files and bibliographies have been generated in the NSRDS program and elsewhere on punched cards, stored as card images on magnetic tape, or written as fixed length records on magnetic tape. Such files are usually formatted to conserve space. Thus, labels or other identifiers are luxuries that few programers indulge in when designing a file. In fact, in many files, the decimal points and blank spaces are omitted from the stored data. These are inserted later during the printout in accord with specific instructions via format cards. While the insertion of decimal points and spaces between columns of numbers is relatively easy, the insertion of textual material requires considerably more labor.

Reform is an independent program with which it is possible to manipulate and edit files containing as many as nine different fixed-field card formats. It can select or abridge information from any of the cards and print that information, or reformat new cards in any desired order or arrangement. Provision is made for introducing as many as 26 arbitrary strings of characters, each of which may be up to 79 characters in length, thereby permitting the insertion of labels, headings, or comments into the file. The program is written in ASA FORTRAN, and care has been taken to reduce to a minimum the program changes required to make the program run on different computers. The report contains worked-out examples of applications, as well as computer listings.

By-Products of NSRDS Compilation Activities

Two recent papers are by-products of compilation activities supported by the Office of Standard Reference Data. The Biradical Mechanism in Small Ring Compound Reactions, by H. E. O'Neal and S. W. Benson, was published in the June 1968 issue of the *Journal of Physical Chemistry.* It discusses the kinetics of dissociation, structural isomerization, and geometric isomerization in three- and four-membered cyclic compounds in terms of the biradical mechanism. With the exceptions of the cyclobutene isomerizations and the cis-1,2-alkylvinylcyclopropane isomerizations, all small ring compound reactions to date are shown to be both qualitatively and quantitatively consistent with the biradical mechanism. Methods for making a priori transition-state estimates of the activation energies (E) and Arrhenius (A) factors for these reactions are outlined in the paper. Estimates are shown to be reliable to about 0.3 log unit in A and about 1.5 kcal/mol in E, on the average. The thermochemistry of fluorine substitution in cyclopropanes and cyclobutanes, and its effect on the mechanism and kinetics of fluorinated small ring compound reactions, is also discussed.

The second paper, Molten Salt Electromotive Force Formation Cells, by Chris Dijkhuis, Ria Dijkhuis, and George J. Janz, was published in the May 1968 issue of *Chemical Reviews.* Evaluated data for a group of binary molten salt mixtures are used to determine excess free energies, heats, and entropies of the mixtures. The magnitudes of the excess free energies are generally small when compared with the lattice contribution to the free energy. There appear to be regularities with respect to ion type, but the data are not extensive enough to correlate thermodynamic properties and single ion properties.

[1] These publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the prices indicated.

[2] Standard X-Ray Diffraction Powder Patterns, NBS Mono. 25—Section 4, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 55 cents.

326-437 O - 69 - 2

1968 Actions . . .
INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES

The International Committee of Weights and Measures, meeting in Sèvres, France, in October 1968, approved a new International Practical Temperature Scale extending down to much lower temperatures than before. The Committee had been authorized to take this action by the 13th General Conference of Weights and Measures which met in October of the previous year.[1] Other technical actions taken by the Committee included a change in the reference base of the volt and in the accepted values of the gyromagnetic ratio of the proton and the acceleration due to gravity at Potsdam. In addition, major decisions were made affecting international cooperation in radiofrequency measurements, accurate time dissemination, and standard reference materials.

The new International Practical Temperature Scale of 1968 (abbreviated EIPT–68 in French, and IPTS–68 in English) is defined in terms of a series of fixed points and interpolation formulas for specified instruments used to realize the scale. It differs from the previous scale, the International Practical Temperature Scale of 1948 [2] (IPTS–48), in the following ways:

(1) The new scale extends down to 13.8 K; IPTS–48 terminated at 90.18 K.

(2) New values have been assigned to most of the defining fixed points and to the second radiation constant, C_2, in order to more closely approximate the thermodynamic temperature scale.

Table 1 lists the approximate differences between the values of temperature given by IPTS–68 and IPTS–48.

The text of the new scale is expected to be published in the April 1969 issue of *Metrologia*. After that date, reprints will be made available by the National Bureau of Standards, and presumably by other national standards laboratories, on request.

It is hoped that NBS will be able both to calibrate thermometers on the new scale and to make adjustments (where appropriate) for prior calibrations very shortly after the appearance of the new text in Metrologia.

The Committee's action on the volt authorized the International Bureau of Weights and Measures (BIPM) to decrease the volt, as maintained, by 11 parts per million. This brings the "practical" volt into much better agreement with the theoretically defined volt, which is derived from the basic mechanical units of length, mass, and time.[3] The change, effective January 1, 1969, will be accompanied by appropriate changes at the various national laboratories throughout the world, so that the volt as maintained by each country will agree with the volt maintained by the International Bureau. As a result, the *measured*

Table 1. *Approximate differences* ($t_{68} - t_{48}$) *in kelvins between the values of temperature given by IPTS–68 and IPTS–48*

t_{68} °C	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−100	0.022	0.013	0.003	−0.006	−0.013	−0.013	−0.005	0.007	0.012	.....	.....
0	0.000	0.006	0.012	0.018	0.024	0.029	0.032	0.034	0.033	0.029	0.022

t_{68} °C	0	10	20	30	40	50	60	70	80	90	100
0	0.000	−0.004	−0.007	−0.009	−0.010	−0.010	−0.010	−0.008	−0.006	−0.003	0.000
100	0.000	0.004	0.007	0.012	0.016	0.020	0.025	0.029	0.034	0.038	0.043
200	0.043	0.047	0.051	0.054	0.058	0.061	0.064	0.067	0.069	0.071	0.073
300	0.073	0.074	0.075	0.076	0.077	0.077	0.077	0.077	0.077	0.076	0.076
400	0.076	0.075	0.075	0.075	0.074	0.074	0.074	0.075	0.076	0.077	0.079
500	0.079	0.082	0.085	0.089	0.094	0.100	0.108	0.116	0.126	0.137	0.150
600	0.150	0.165	0.182	0.200	0.22	0.25	0.27	0.30	0.32	0.35	0.38
700	0.38	0.40	0.43	0.46	0.48	0.51	0.54	0.57	0.60	0.62	0.65
800	0.65	0.68	0.71	0.74	0.77	0.80	0.83	0.86	0.89	0.92	0.94
900	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.24
1000	1.24	1.27	1.30	1.33	1.36	1.39	1.42	1.44	.....	.....	.....

t_{68} °C	0	100	200	300	400	500	600	700	800	900	1000
1000	.....	1.5	1.7	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
2000	3.2	3.5	3.7	4.0	4.2	4.5	4.8	5.0	5.3	5.6	5.9
3000	5.9	6.2	6.5	6.9	7.2	7.5	7.9	8.2	8.6	9.0	9.3

UNITED STATES DEPARTMENT OF COMMERCE
C. R. SMITH, Secretary
NATIONAL BUREAU OF STANDARDS / A. V. ASTIN, Director
Special Publication 304A. Issued 1968.

Brief History and Use of

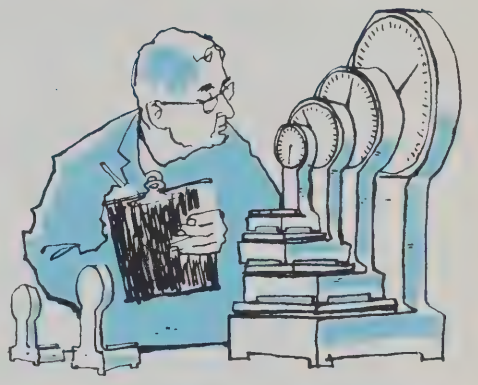
THE ENGLISH AND METRIC SYSTEMS OF MEASUREMENT

with a

CHART OF THE MODERNIZED METRIC SYSTEM

"Weights and measures may be ranked among the necessaries of life to every individual of human society. They enter into the economical arrangements and daily concerns of every family. They are necessary to every occupation of human industry; to the distribution and security of every species of property; to every transaction of trade and commerce; to the labors of the husbandman; to the ingenuity of the artificer; to the studies of the philosopher; to the researches of the antiquarian, to the navigation of the mariner, and the marches of the soldier; to all the exchanges of peace, and all the operations of war."

—JOHN QUINCY ADAMS



When the American Colonies separated from the mother country to assume among the nations of the earth a separate and individual station, they retained, among other things, the weights and measures that had been used when they were colonies, namely, the weights and measures of England. It is probable that these were at that time the most firmly established and widely used weights and measures in the world.

England a highly coherent nation, separated by sea from many of the turmoils of the European continent, had long before established standards for weights and measures that have remained essentially unchanged up to the present time. The yard, established by Henry II, differs only by about 1 part in a thousand from the yard of today. The pound of Queen Elizabeth I shows similar agreement with the present avoirdupois pound.

No such uniformity of weights and measures existed on the European continent. Weights and measures differed not only from country to country, but even from town to town and from one trade to another. This lack of uniformity led the National Assembly of France on May 8, 1790, to enact a decree, sanctioned by Louis XVI, which called upon the French Academy of Sciences in concert with the Royal Society of London to "deduce an invariable standard for all of the measures and all weights." Having already an adequate system of weights and measures, the English were not interested in the French undertaking, so the French proceeded with their endeavor alone. The result is what is known as the metric system.

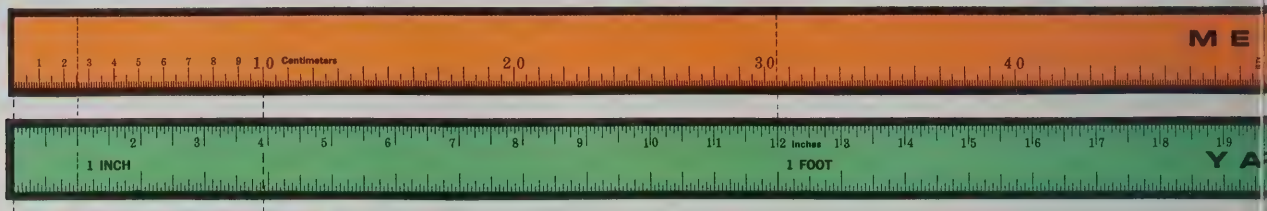
The metric system was conceived as a measurement system to the base ten; that is, the units of the system, their multiples, and submultiples should be related to each other by simple factors of ten. This is a great convenience because it conforms to our common system for numerical notation, which is also a base ten system. Thus to convert between units, their multiples, and submultiples, it is not necessary to perform a difficult multiplication or division process, but simply to shift the decimal point. The system seems to have been first proposed by Gabriel Mouton, a vicar of Lyons, France, in the late 17th century. He proposed to define the unit of length for the system as a fraction of the length of a great circle of the earth. This idea found favor with the French philosophers at the time of the French Revolution, men who were generally opposed to any vestige of monarchical authority and preferred a standard based on a constant of nature.

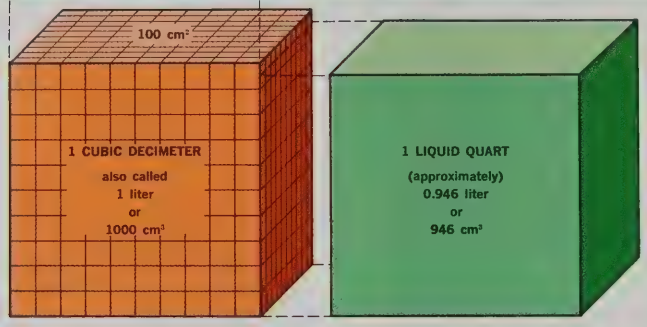
The French Academy assigned the name mètre (meter), from the Greek *metron*, a measure, to the unit of length which was supposed to be one ten millionth of the distance from the north pole to the equator, along the meridian running near Dunkirk, Paris, and Barcelona. An attempt was made to measure this meridian from northern France to southern France, from which the true distance from the pole to the equator could be calculated. The best techniques then available were used. Although the operations were carried out during a politically disturbed time, the results were in error only by about 2000 meters, a remarkable achievement in those days.

Meanwhile the National Assembly had preempted the geodetic survey, upon which the meter was to be based, and established a provisional meter. The unit of mass called the gram was

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402—Price 20 cents

The Modernized Metric Sys



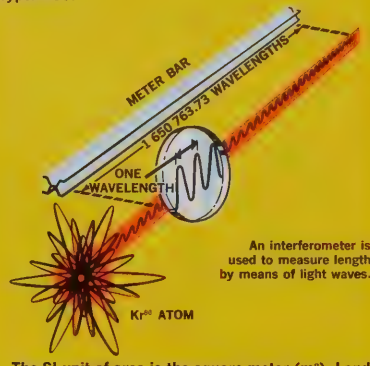


THE International System of Units—
viated SI—is a modernized versio
system. It was established by inte
ment to provide a logical and interconne
for all measurements in science, industry,
SI is built upon a foundation of base unit
nitions, which appear on this chart. All o

The Six Base Units of Measuren

Length METER—m

The meter is defined as 1 650 763.73 wavelengths in vacuum of the orange-red line of the spectrum of krypton-86.


METER BAR
1 650 763.73 WAVELENGTHS
ONE WAVELENGTH
An interferometer is used to measure length by means of light waves.
Kr⁸⁶ ATOM

The SI unit of area is the square meter (m²). Land is often measured by the hectare (10 000 square meters, or approximately 2.5 acres).

The SI unit of volume is the cubic meter (m³). Fluid volume is often measured by the liter (0.001 cubic meter).

1968

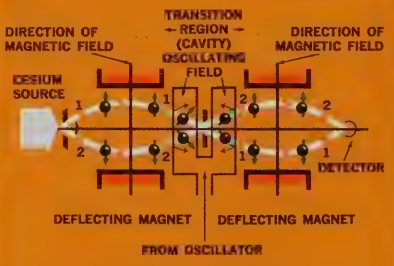
National Bureau of Standards Special Publication 304 A
(Supersedes Miscellaneous Publication 232)
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 20 cents

References:

NBS Handbook 102, ASTM Metric Practice Guide, 40 cents
NBS Misc. Publ. 247, Weights and Measures Standards of the United States, A Brief History, 35 cents
NBS Misc. Publ. 286, Units of Weight and Measure, Definitions and Tables of Equivalents, $1.50

Time SECOND-s

The second is defined as the duration of 9 192 631 770 cycles of the radiation associated with a specified transition of the cesium atom. It is realized by tuning an oscillator to the resonance frequency of the cesium atoms as they pass through a system of magnets and a resonant cavity into a detector.



A schematic of an atomic beam spectrometer. The trajectories are drawn for those atoms whose magnetic moments are "flipped" in the transition region.

The number of periods or cycles per second is called frequency. The SI unit for frequency is the hertz (Hz). One hertz equals one cycle per second.

Standard frequencies and correct time are broadcast from NBS stations WWV, WWVB, WWVH, and WWVL, and stations of the U.S. Navy.

Many shortwave receivers pick up WWV on frequencies of 2.5, 5, 10, 15, 20, and 25 megahertz. The standard radio broadcast band extends from 535 to 1605 kilohertz.

Dividing distance by time gives speed. The SI unit for speed is the meter per second (m/s), approximately 3 feet per second.

Rate of change in speed is called acceleration. The SI unit for acceleration is the meter per second per second (m/s²).

Mass KILOGRAM—kg

The standard for the unit of mass, the kilogram, is a cylinder of platinum-iridium alloy kept by the International Bureau of Weights and Measures at Paris. A duplicate in the custody of the National Bureau of Standards serves as the mass standard for the United States. This is the only base unit still defined by an artifact.

Closely allied to the concept of mass is that of force. The SI unit of force is the newton (N). A force of 1 newton, when applied for 1 second, will give to a 1 kilogram mass a speed of 1 meter per second (an acceleration of 1 meter per second per second).

$$1\text{N} = \frac{1\text{kg} \cdot 1\text{m}}{1\text{s}^2}$$

One newton equals approximately two tenths of a pound of force.

The weight of an object is the force exerted on it by gravity. Gravity gives a mass a downward acceleration of about 9.8m/s².

The SI unit for work and energy of any kind is the joule (J).

$$1\text{J} = 1\text{N} \cdot 1\text{m}$$

The SI unit for power of any kind is the watt (W).

$$1\text{W} = \frac{1\text{J}}{1\text{s}}$$

This chart is one-third the actual size of the full-scale wall chart, NBS Special Publication 304, which is availab

stem The International System of Units (SI) and its relationship to U.S. customary units

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

ficially abbre-
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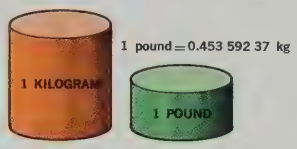
r SI units are

derived from these base units. Multiples and submultiples are expressed in a decimal system. Use of metric weights and measures was legalized in the United States in 1866, and our customary units of weights and measures are defined in terms of the meter and the kilogram. The only legal units for electricity and illumination in the United States are SI units.

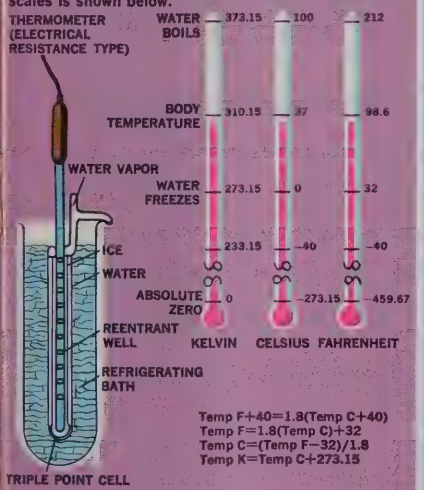
The kilogram shown here approximates one third the size of the platinum-iridium standard of mass. One pound of the same material would be three times the size shown below.



ent definitions, abbreviations, and some SI units derived from them

Temperature KELVIN–K

The thermodynamic or Kelvin scale of temperature used in SI has its origin or zero point at absolute zero and has a fixed point at the triple point of water defined as 273.16 kelvins. The Celsius scale is derived from the Kelvin scale. The triple point is defined as 0.01 °C on the Celsius scale, which is approximately 32.02 °F on the Fahrenheit scale. The relationship of the Kelvin, Celsius, and Fahrenheit temperature scales is shown below.



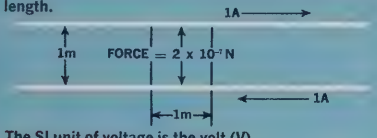
Temp F+40=1.8(Temp C+40)
Temp F=1.8(Temp C)+32
Temp C=(Temp F−32)/1.8
Temp K=Temp C+273.15

TRIPLE POINT CELL

The triple point cell, an evacuated glass cylinder filled with pure water, is used to define a known fixed temperature. When the cell is cooled until a mantle of ice forms around the reentrant well, the temperature at the interface of solid, liquid, and vapor is 0.01 °C. Thermometers to be calibrated are placed in the reentrant well.

Electric Current AMPERE–A

The ampere is defined as the magnitude of the current that, when flowing through each of two long parallel wires separated by one meter in free space, results in a force between the two wires (due to their magnetic fields) of 2×10^{-7} newton for each meter of length.



The SI unit of voltage is the volt (V).

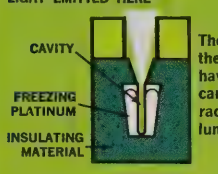
$$1V = \frac{1W}{1A}$$

The SI unit of electrical resistance is the ohm (Ω).

$$1\ \Omega = \frac{1V}{1A}$$

Luminous Intensity CANDELA–cd

The candela is defined as the luminous intensity of 1/600 000 of a square meter of a radiating cavity at the temperature of freezing platinum (2042 K).



The SI unit of light flux is the lumen (lm). A source having an intensity of 1 candela in all directions radiates a light flux of 4π lumens.

A 100-watt light bulb emits about 1700 lumens

COMMON EQUIVALENTS AND CONVERSIONS

Approximate Common Equivalents		Conversions Accurate to Parts Per Million	
1 inch	=25 millimeters	inches x 25.4*	=millimeters
1 foot	=0.3 meter	feet x 0.3048*	=meters
1 yard	=0.9 meter	yards x 0.9144*	=meters
1 mile	=1.6 kilometers	miles x 1.609 34	=kilometers
1 square inch	=6.5 sq centimeters	square inches x 6.4516*	=sq centimeters
1 square foot	=0.09 square meter	square feet x 0.092 903 0	=square meters
1 square yard	=0.8 square meter	square yards x 0.836 127	=square meters
1 acre	=0.4 hectare +	acres x 0.404 686	=hectares
1 cubic inch	=16 cu centimeters	cubic inches x 16.3871	=cu centimeters
1 cubic foot	=0.03 cubic meter	cubic feet x 0.028 316 8	=cubic meters
1 cubic yard	=0.8 cubic meter	cubic yards x 0.764 555	=cubic meters
1 quart (liq)	=1 liter +	quarts (liq) x 0.946 353	=liters
1 gallon	=0.004 cubic meter	gallons x 0.003 785 41	=cubic meters
1 ounce (avdp)	=28 grams	ounces (avdp) x 28.349 5	=grams
1 pound (avdp)	=0.45 kilogram	pounds (avdp) x 0.453 592	=kilograms
1 horsepower	=0.75 kilowatt	horsepower x 0.745 700	=kilowatts
1 millimeter	=0.04 inch	millimeters x 0.039 370 1	=inches
1 meter	=3.3 feet	meters x 3.280 84	=feet
1 meter	=1.1 yards	meters x 1.093 61	=yards
1 kilometer	=0.6 mile	kilometers x 0.621 371	=miles
1 sq centimeter	=0.16 square inch	sq centimeters x 0.155 000	=square inches
1 square meter	=11 square feet	square meters x 10.7639	=square feet
1 square meter	=1.2 square yards	square meters x 1.195 99	=square yards
1 hectare +	=2.5 acres	hectares x 2.471 05	=acres
1 cu centimeter	=0.06 cubic inch	cu centimeters x 0.061 023 7	=cubic inches
1 cubic meter	=35 cubic feet	cubic meters x 35.3147	=cubic feet
1 cubic meter	=1.3 cubic yards	cubic meters x 1.307 95	=cubic yards
1 liter +	=1 quart (liq)	liters x 1.056 69	=quarts (liq)
1 cubic meter	=250 gallons	cubic meters x 264.172	=gallons
1 gram	=0.035 ounces (avdp)	grams x 0.035 274 0	=ounces (avdp)
1 kilogram	=2.2 pounds (avdp)	kilograms x 2.204 62	=pounds (avdp)
1 kilowatt	=1.3 horsepower	kilowatts x 1.341 02	=horsepower

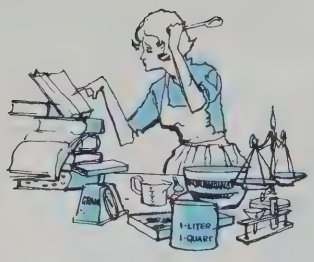
+ common term not used in SI * exact

THESE PREFIXES MAY BE APPLIED TO ALL SI UNITS

Multiples and Submultiples	Prefixes	Symbols
$1\,000\,000\,000\,000 = 10^{12}$	tera (tĕr′ə)	T
$1\,000\,000\,000 = 10^{9}$	giga (jĭ′gə)	G
$1\,000\,000 = 10^{6}$	mega (mĕg′ə)	M *
$1000 = 10^{3}$	kilo (kĭl′ō)	k *
$100 = 10^{2}$	hecto (hĕk′tō)	h
$10 = 10$	deka (dĕk′ə)	da
$0.1 = 10^{-1}$	deci (dĕs′ĭ)	d
$0.01 = 10^{-2}$	centi (sĕn′tĭ)	c *
$0.001 = 10^{-3}$	milli (mĭl′ĭ)	m *
$0.000\,001 = 10^{-6}$	micro (mī′krō)	μ *
$0.000\,000\,001 = 10^{-9}$	nano (năn′ō)	n
$0.000\,000\,000\,001 = 10^{-12}$	pico (pē′kō)	p
$0.000\,000\,000\,000\,001 = 10^{-15}$	femto (fĕm′tō)	f
$0.000\,000\,000\,000\,000\,001 = 10^{-18}$	atto (ăt′tō)	a

*Most commonly used

om the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 50 cents.



decided on as the mass of one cubic centimeter of water at its temperature of maximum density. Since this was too small a quantity to be measured with the desired precision the determination was made on one cubic decimeter of water, but even at that the results were found to be in error by about 28 parts in a million. Thus, the meter that was established as the foundation of the system did not approximate the idealized definition on which it was based with the desired accuracy. Also the unit of mass differed from the idealized definition even as given in terms of the erroneously defined meter. So the new system was actually based on two metallic standards not differing greatly in nature from the yard of Henry II or the pound of Elizabeth I.

As a unit for fluid capacity, the founders selected the cubic decimeter and as a unit for land area they selected the are, equal to a square ten meters on the side. In this manner, while decimal relationships were preserved between the units of length, fluid capacity, and area, the relationships were not kept to the simplest possible form. Although there was some discussion at the time of decimalizing the calendar and the time of day, the system did not include any unit for time.

The British system of weights and measures, and the metric system as well, had been developed primarily for use in trade and commerce rather than for purposes of science and engineering.

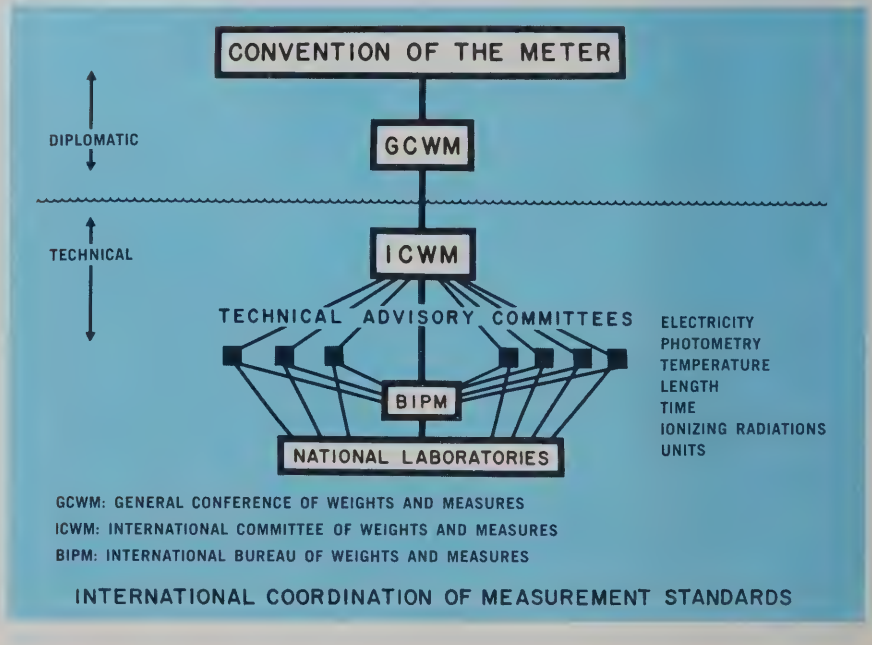
Because technological achievement depends to a considerable extent upon the ability to make physical measurements, the Americans and the British proceeded to adapt their system of measurements to the requirements of the new technology of the 19th century, despite the fact that the newly developed metric system seemed to have certain points of superiority. Both the United States and Great Britain soon had vast investments in a highly industrialized society based on their own system.

The new metric system found much favor with scientists of the 19th century, partly because it was intended to be an international system of measurement, partly because the units of measurement were theoretically supposed to be independently reproducible, and partly because of the simplicity of its decimal nature. These scientists proceeded to derive new units for the various physical quantities with which they had to deal, basing the new units on elementary laws of physics and relating them to the units of mass and length of the metric system. The system found increasing acceptance in various European countries which had been plagued by a plethora of unrelated units for different quantities.

Because of increasing technological development there was a need for international standardization and improvements in the accuracy of standards for units of length and mass. This led to an international meeting in France in 1872, attended by 26 countries including the United States. The meeting resulted in an international treaty, the Metric Convention, which was signed by 17 countries, including the United States in 1875. This treaty set up well defined metric standards for length and mass, and established the International Bureau of Weights and Measures. Also established was the General Conference of Weights and Measures, which would meet every six years to consider any needed improvements in the standards and to serve as the authority governing the International Bureau. An International Committee of Weights and Measures was also set up to implement the recommendations of the General Conference and to direct the activities of the International Bureau; this Committee meets every two years.

Since its inception nearly 175 years ago, the number of countries using the metric system has been growing rapidly. The original metric system of course had imperfections; and it has since undergone many revisions, the more recent ones being accomplished through the General Conference of Weights and Measures. An extensive revision and simplification in 1960 by the then 40 members of the General Conference resulted in a modernized metric system—the International System of Units—which is described in detail in the accompanying chart.

NOTE: For further information see the references listed on the chart. In addition, a more complete treatment of the English and metric systems of measurement will soon be available.



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value of a truly constant voltage will increase, since the unit is being made smaller.

The change in the U.S. legal volt, as maintained by a group of standard cells at NBS, will be 8.4 parts per million, because the NBS volt and the BIPM volt have drifted apart by 2.6 parts per million since the last adjustment. In calibration reports issued by NBS during 1969, values will be given on the new basis. Values on the old basis will also be supplied so that the user will be advised directly of the change.

The Committee also accepted a recommendation from its Advisory Committee on Electricity that "for international metrological usage, the value of the gyromagnetic ratio of the proton in water, without diamagnetic correction, be taken as

$$\gamma_p' = 2.675\ 12 \times 10^8\ \text{rad}\cdot\text{s}^{-1}\,\text{T}^{-1}$$

which can be expressed in the equivalent form, often better adapted to practical usage,

$$\nu_p' = \frac{\gamma_p'}{2\pi} = 42.5759\ \text{MHz}\cdot\text{T}^{-1}\text{''}$$

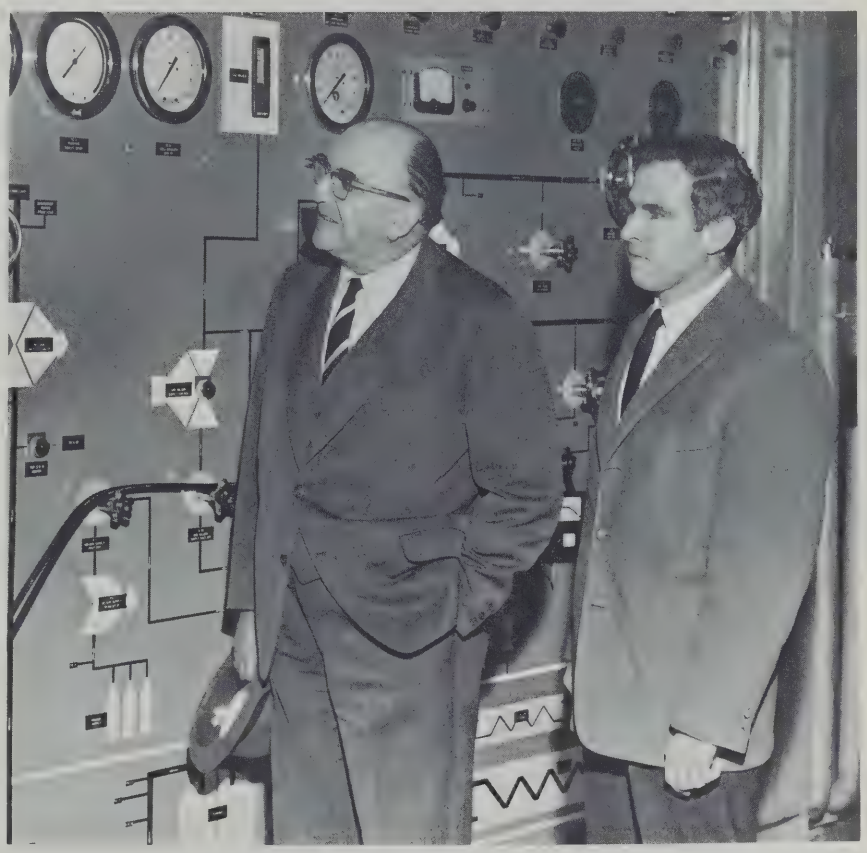
This recommendation also took effect on January 1; the values given have been adjusted in accordance with the January 1 change in the volt (and ampere).

In a similar updating of knowledge, the Committee decided that "for metrological needs, the value of the acceleration of gravity at Potsdam, which is the point of departure of the Potsdam System, be taken as 9.812 60 $\text{m}\cdot\text{s}^{-2}$, and no longer as 9.812 74, the initially adopted value."

Plans for broadened activity in international comparisons of measurements of radiofrequency quantities (power, voltage, attenuation, etc.) were noted and approved.

A report from the preparatory committee for the international coordination of time scales was accepted. This report lays the groundwork for the international adoption of an improved system for disseminating accurate time, so necessary for precise navigation.

J. M. Otero (left), the new Chairman of the International Committee of Weights and Measures, inspects the NBS Reactor during his recent visit to the Bureau. He is accompanied by R. S. Carter of the NBS Center for Radiation Research.



The Committee approved an NBS proposal to cosponsor an International Symposium on Standard Reference Materials at the Bureau's Gaithersburg (Md.) laboratories during the week of May 26, 1969. The Symposium will consider the possibilities for international cooperation in the preparation, characterization, and distribution of standard reference materials. Each of the 40 nations adhering to the Treaty of the Meter will be invited to participate.

L. E. Howlett, who has served as Chairman of the International Committee of Weights and Measures since 1964, submitted his resignation because of his retirement from his former position as Director of the Applied Physics Division of the National Research Council of Canada. As its new Chairman the Committee elected its Vice-Chairman, J. M. Otero, who is Chairman of Spain's National Center of Nuclear Energy. J. V. Dunworth, Director of the British National Physical Laboratory, was elected as the new Vice-Chairman of the Committee. J. de Boer, Director of the Institute of Theoretical Physics of the University of Amsterdam, continues as Secretary of the Committee.

[1] Atomic second adopted as international unit of time, NBS Tech. News Bull. **52**, No. 1, 10–12 (Jan. 1968).

[2] Stimson, H. F., International Practical Temperature Scale of 1948: Text Revision of 1960, NBS Mono. **37**, for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20234. Price 10 cents.

[3] Reference base of the volt to be changed, NBS Tech. News Bull. **52**, No. 9, 204–206 (Sept. 1968).

CONFERENCE *Briefs*

The Friday afternoon plenary panel session discussed biomedical applications, geochemical and cosmochemical applications, the use of charged particles and photons, and the use of "fast" neutrons. Panel members are (left to right): W. Wayne Meinke, NBS; Herbert P. Yule, Texas A&M University; Charles Engelmann, Center for Nuclear Studies, Saclay, France; Dominique Comar, Atomic Energy Commission, Gif-sur-Yvette, France; Jean Laverlochere, Center for Nuclear Studies, Grenoble, France; and Hiroshi Hamaguchi, University of Tokyo.

THIRD INTERNATIONAL ACTIVATION ANALYSIS CONFERENCE

During the week of October 7–11, 1968, the National Bureau of Standards played host to over 400 scientists from the United States and 27 other countries who were attending the Third International Conference on Activation Analysis. Entitled "The 1968 Conference, Modern Trends in Activation Analysis," the Conference was designed to bring together all those interested in activation analysis. About one-fourth of the participants were from foreign countries. The meeting was jointly sponsored by the National Bureau of Standards, the U.S. Atomic Energy Commission, the International Atomic Energy Agency, and EURISOTOP of the European Communities Commission. General Chairman and Assistant General Chairman of the Conference were James R. DeVoe and Philip D. LaFleur, respectively, both of whom are members of the NBS Analytical Chemistry Division.

Plenary lectures were held during the first hour of each morning to orient attendees regarding the major field of activation analysis for that day, the current state of the art, and future developments in the field. The five lecturers, speaking on successive days, were: Julian Hoste, University of Ghent, Belgium; J. M. A. Lenihan, Western Regional Hospital Board, Glasgow, Scotland; Francesco Girardi, EURATOM Communities, Ispra, Italy; Russell L. Heath, Idaho Nuclear Corp., Idaho Falls; and Herbert Yule, Texas A&M University, College Station.

Since more than 160 technical papers were presented at the Conference, it was necessary to schedule simultaneous technical sessions. Plenary sessions were also held after each day's simultaneous sessions to review the technical papers presented. These sessions were panel discussions that brought out the important points of each session. This arrangement permitted participants to obtain the maximum benefit from the Conference despite the inconvenience of simultaneous sessions. The panels consisted of the chairmen of the various technical sessions, the plenary lecturer for the day, and the panel moderator, W. Wayne Meinke, Chief, NBS Analytical Chemistry Division.

Plenary Lectures

Because of limited space, the technical papers will not be reviewed here. The following is a brief description of the plenary lectures. Professor Hoste began the series by discussing the type of nuclear reactions used in activation analysis, and the methods of solving problems associated with sample irradiation, such as those of flux monitors and self-shielding. Dr. Lenihan's talk on Tuesday concerned the application of activation analysis to problem areas such as medical research, space sciences, geology, and pollution. He also discussed the interaction between science and technology.

On Wednesday, Dr. Girardi reviewed the application of radiochemical separations to activation analysis. He discussed some very interesting innovations in automated techniques and in the use of hydrated antimony pentoxide for removing radioactive sodium—a major problem in

working with biological samples because of the intense radioactivity. The following day, Dr. Heath spoke about the application of semiconductor detectors to activation analysis. He traced the history of solid state radiation detectors and explained the proper use of these devices. Dr. Heath also described methods of evaluating the characteristics of various detector configurations. His remarks were highly pertinent since the use of these detectors for activation analysis is becoming widespread.

Professor Yule provided an excellent summary of the computation and data reduction activities in activation analysis in his lecture on Friday. He discussed the various methods of gamma-ray peak identification and peak integration, including the various problems in background subtraction.

A reception and buffet was held Wednesday evening in the dining room of the Museum of History and Technology of the Smithsonian Institution. Sidney R. Galler, Assistant Secretary of the Smithsonian for Science, spoke on "Museums: Bridge Between the Sciences and the Humanities." Dr. Galler pointed out the importance of memorabilia in tying science and the humanities together.

One of the highlights of the Conference was the presentation of the first George Von Hevesy medal. Sponsored by the *Journal of Radioanalytical Chemistry,* the award was presented to W. Wayne Meinke in recognition of his outstanding work in radioanalytical chemistry and for his efforts in helping activation analysis to be recognized as a technique for trace elemental analysis. In his acceptance speech, Dr. Meinke stated that the award was actually in recognition of the excellent work of his graduate students, his postdoctoral associates, and his other coworkers at the University of Michigan and at NBS.

All of the technical papers and the plenary lectures will be included in the proceedings of the Conference, which will be published in early 1969. The technical papers were prepared on a magnetic tape-coupled typewriter and issued as preprints; the plenary lectures were likewise prepared on magnetic tape during the Conference. Together these tapes will be converted to computer-compatible magnetic tape and the entire proceedings will be typeset by computer at the U.S. Government Printing Office. Their availability will be announced as soon as they are published.

SYMPOSIUM ON ELECTRON, ION, AND LASER BEAM TECHNOLOGY

The 10th Symposium on Electron, Ion, and Laser Beam Technology will be held May 21–23, 1969, at the new Gaithersburg (Md.) facilities of the National Bureau of Standards. Sponsored by NBS, the University of Maryland, the Institute of Electrical and Electronics Engineers' Group on Electron Devices, and the American Vacuum Society, the Symposium will be open to all scientists interested in the subjects covered.

Advances in experimental techniques and applications to the problems of modern science will be discussed under such topics as Sources and Handling Techniques in Beam Physics; Thermal and Nonthermal Interactions; Applications of Beams in such areas as Electron Microscopy, Computer Memories, Displays, Ion Implantation, Biology, Medicine, Micromachining, and Welding. No time will be given to the application of lasers to communications and holography, as these will be the subjects of a separate conference.

Abstracts of contributed papers are being accepted through January 31, 1969. Additional information may be obtained from L. L. Marton, Conference Chairman; 10th Symposium on Electron, Ion, and Laser Beam Technology; Rm. A1013, Administration Bldg.; National Bureau of Standards; Washington, D.C. 20234.

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. For further information, address the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

Symposium on Ion-Selective Electrodes. Jan. 30–31. Contact: R. A. Durst (NBS Analytical Chemistry Division).

1969 Particle Accelerator Conference. Mar. 5–7. Cosponsors: American Physical Society, Institute of Electrical and Electronics Engineers (NSG), National Science Foundation, U.S. Atomic Energy Commission. Contact: E. H. Eisenhower (NBS Center for Radiation Research). To be held at the Shoreham Hotel, Washington, D.C.

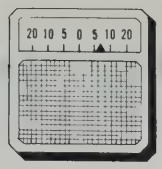
Thermodynamics of Bulk Polymers Symposium. Mar. 10–11. Contact: A. B. Bestul (NBS Polymers Division).

Fundamental Aspects of Dislocation Theory. Apr. 21–25. Contact: J. Simmons (NBS Metallurgy Division).

NRCA–NBS Joint Symposium on Roofing. Apr. 29–30. Cosponsor: National Roofing Contractors Association. Contact: T. H. Boone (NBS Building Research Division).

10th Symposium on Electron, Ion, and Laser Beam Technology. May 21–24. Cosponsors: University of Maryland, Institute for Electrical and Electronics Engineers (GED), American Vacuum Society. Contact: L. Marton (NBS).

NBS Measurement Seminars and Workshops 1968–1969. Two- to five-day courses on measurement and calibration problems. Attendance limited. See October 1968 *Technical News Bulletin* for detailed information.



STANDARDS AND CALIBRATION

NOISE SOURCES IN FOUR WAVEGUIDE SIZES

Calibration services for the measurement of effective noise temperature of noise sources in four additional waveguide sizes have been announced by the NBS Radio Standards Engineering Division (Boulder, Colo.). The services are available in WR284 waveguide (2.60–3.95 GHz), WR75 waveguide (10.0–15.0 GHz), and in the limited ranges of 3.30 to 3.95 GHz for WR229 waveguide and 8.2 to 10.0 GHz for WR112 waveguide. Calibration services have been available in WR62 and WR90 waveguide for several years.

Waveguide noise sources calibrated by NBS are used as interlaboratory standards by other laboratories. In turn, the interlaboratory standards are used to calibrate other noise standards until the end result is reached of measuring the performance of manufactured equipment or of equipment that is in service. Examples of such equipment are mixers, amplifiers, and complete receivers. This type of equipment is used in the assemblies of complex and complete systems for communications, various radar applications, and for radio astronomy.

The equipment used for the WR75 and WR112 calibration services is adapted from that described several years ago.[1] This equipment has been modified in the following ways: (1) The resistive noise generators, formerly fabricated from silicon carbide, have been replaced by a ceramic composed of silicon carbide imbedded in beryllium oxide; (2) the gold waveguide that housed the noise generator has been replaced by a platinum–13 percent rhodium alloy, which has greater stability at the operating temperatures; (3) the waveguide is surrounded by a beryllium oxide heat distributor that replaces the former one of zirconia-coated graphite.

In scaling up to the larger WR284 waveguide size it was found desirable to change design features of the reference noise generator and the radiometer system. The noise generator consists of a block of silicon carbide imbedded in beryllium oxide to which a tuning device was added. The tuning device consists of a rod tipped with a small metallic "paddle" that has two degrees of movement in the vicinity of the resistive noise generator. Changed design features of the switching radiometric system include the use of a ferrite switch, a parametric amplifier (to increase the sensitivity of the measurement system), and a tunable bandpass filter (to eliminate the IF image and reduce the receiver to single sideband operation).

The range of effective noise temperature measurement under conditions of continuous unmodulated operation is 1000 to 300 000 K for noise sources in WR75 and WR112 waveguide, and 700 to 300 000 K in WR229 and WR284 waveguide. Expressed as excess noise ratio, the range is 4 to 30 dB for noise sources in WR75 and WR112 waveguide, and 1.5 to 30 dB in WR229 and WR284 waveguide.

At present there are certain limitations to the number of frequencies at which effective noise temperature measurements can be made in the four waveguide sizes. In WR284 waveguide the suggested frequencies are 2.85, 3.25, and 3.75 GHz.[2] In WR 229 waveguide the only available frequency is 3.75 GHz. A selection of calibration frequencies is available in WR112 and in WR75 waveguide.[3]

Waveguide noise sources submitted for calibration should have the gas-discharge tube noise generator securely fitted to the waveguide mount, which, in turn, must be terminated at one end with a suitable matched load. The waveguide flange for mating of the noise source to the measurement system must be of a cover type as noted below.

Direct current required for normal operation of the gas-discharge tube should not exceed 300 mA but should be sufficient to prevent excessive plasma oscillations. Complete information on the operating current of the tube and a wiring diagram of the noise source must be supplied.

For a reflection coefficient magnitude less than 0.09 (VSWR less than 1.2), the following listing of the limits of uncertainties applies for the effective noise temperatures and excess noise ratios (ENR) for agron-filled gas-discharge noise sources.

Waveguide size of noise source	Waveguide flange	Effective noise temperature	Excess noise ratio
WR75 (10.0–15.0 GHz)	Cover type	±175 to 225 K	±0.07 to 0.09 dB
WR112 (8.2–10.0 GHz)[4]	UG-51/U	±175 to 225 K	±0.07 to 0.09 dB
WR229 (3.30–3.95 GHz)[4]	Cover type	±325 to 373 K	±0.13 to 0.15 dB
WR284 (2.60–3.95 GHz)	UG-53/U	±300 to 350 K	±0.12 to 0.14 dB

[1] Calibration of microwave noise sources, NBS Tech. News Bull. **47**, No. 2, 31–34 (Feb. 1963).

[2] For measurements in WR284 waveguide the suggested frequency is usually 3.55 GHz, as noted in NBS Spec. Publ. **250**, Calibration and Test Services of the National Bureau of Standards, p. 7.14, rather than 3.75 GHz. However, present operating conditions of the equipment require that the calibration be performed at the nearby frequency of 3.75 GHz.

[3] For information, contact: Coordinator, Calibration Services; Radio Standards Engineering Division; National Bureau of Standards; Boulder, Colo. 80302.

[4] Limited frequency range of the waveguide size.

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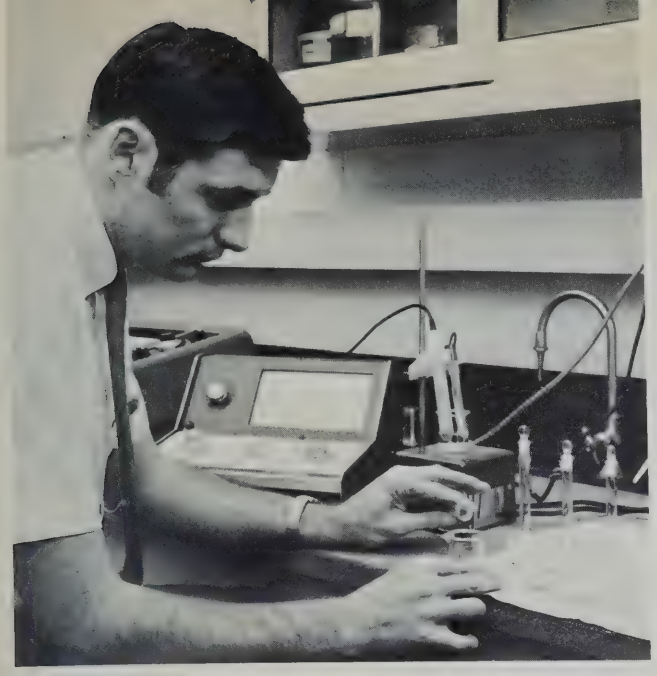


Postdoctoral Associate John Knoeck is working to determine the formation constants of cerium(IV)-nitrate complexes.

POSTDOCTORAL ASSOCIATES BEGIN ADVANCED STUDIES

Sixteen Young Men and Women selected in the 1968–69 Postdoctoral Research Associateship national competition* are arriving at the National Bureau of Standards for a year of advanced research in their chosen fields. Selected on the basis of outstanding ability, these new Ph. D.'s are given the opportunity to further their training and education under the guidance of NBS senior scientists at the Bureau's laboratories either in Gaithersburg, Md., or in Boulder, Colo. NBS is firmly committed to the policy that Federal agencies' participation in this postdoctoral program helps to strengthen the Nation's resources in the physical, engineering, and mathematical sciences.

In 1954 NBS became the first Federal agency to participate in the National Research Council's Research Associateship Program. This program now operates at fourteen Federal laboratories.** In addition to being the oldest, NBS ranks as one of the largest participants, attracting postdoctoral students on the basis of its unique position as the Nation's central laboratory for physical measurement.

The breadth of scientific disciplines represented at the Bureau provides an environment that is highly conducive to a "cross-fertilization" of ideas. Here the Associate is brought into contact with scientists of national and international stature, both within the Bureau's own staff and in other segments of the world's scientific and technological communities with which the Bureau has extensive interaction.

The open manner of the Bureau's activities permits a freedom of movement and exchange of ideas that is found primarily in national laboratories and in academic institutions. The Postdoctoral Research Associate therefore has access to many types of unique research facilities, such as a high-intensity linear accelerator, a 10-megawatt research reactor, a new isotope separator laboratory, sophisticated spectroscopic equipment of many kinds, and crystal growth facilities. Important physical resources that aid productive research include sophisticated computing services, precision measurement facilities, a shop staffed with highly skilled instrument makers, and a superb physical science library of 100 000 volumes. The success of the Postdoctoral Associate program is demonstrated by the quality and performance of its alumni; as a result, the number of applicants has been increasing steadily each year since its inception.

Postdoctoral programs, such as that of NAS–NAE–NRC, have become highly important as a step in the career of the young Ph. D. The additional one or two years of independent research beyond the Ph. D. under the aegis of a nationally recognized institution not only help him to establish himself professionally, but also add to his value as a potential faculty member, career Government worker, or industrial scientist. Increasingly, universities and research laboratories acknowledge the value of postdoctoral research work, as is evidenced by their own promotion of the concept of postdoctoral training and research.

The 16 Associates selected to work at NBS this year are listed below with brief descriptions of their proposed research.

Donald W. Alderman (Cornell Univ.). Dr. Alderman's nuclear magnetic resonance work on impurities in alkali halides (specifically, KCl doped with LiCl) will yield measurements of the Li^7 spin lattice relaxation times of KCl: Li^+. Such measurements would provide valuable insight into the question about the lifetimes of the states of Li^+ in the KCl lattice. (R. J. Mahler, adviser; Boulder)

*Each applicant for a NAS–NAE–NRC postdoctoral position must propose and outline the program of research he wishes to pursue. The applications for all 14 participating laboratories are received in the National Research Council's Office of Scientific Personnel, which has the responsibility for evaluating and ranking applicants. The "quality ranking" is carried out by special selection boards appointed by NRC; these are composed of scientists renowned in their fields of specialization. Final selection of the applicants, however, is made by the individual laboratories. At NBS this responsibility is carried out through the Office of Academic Liaison, which administers the program and maintains close liaison with OSP and members of NRC.

**Agricultural Research Service, Air Force Systems Command, Bureau of Mines, Environmental Science Services Administration, Food and Drug Administration, Fort Detrick, National Bureau of Standards, Naval Bureau of Medicine and Surgery, Naval Electronics Laboratory Center, Naval Ordnance Laboratory, Naval Postgraduate School, Naval Research Laboratory, Naval Weapons Center, and U.S. Geological Survey.

continued

POSTDOCTORAL ASSOCIATES *continued*

Michael J. Bielefeld (Univ. of Pennsylvania) will engage in the analysis and prediction of Mössbauer spectra. His research will attempt to give the Mössbauer spectroscopist a much needed theoretical means for predicting the crystalline structure effect on the quadrupole splitting and the isomer shift parameters of ferrous ion compounds. (J. J. Spijkerman, adviser; Gaithersburg)

Edith F. Borie (Univ. of North Carolina). Dr. Borie's studies in radiation theory will take into account the effects of radiative corrections, target recoil, and target form factors in the scattering of high-energy electrons on heavy nuclei. Her research should improve the accuracy of the calculated cross sections. (L. Maximon, adviser; Gaithersburg)

Arnold M. Denenstein (Univ. of Pennsylvania) will study the use of the ac Josephson effect in maintaining standards of electromotive force. His research should advance the art of voltage measurement and provide a voltage standard with a precision higher than the present one. (C. Page, adviser; Gaithersburg)

Gabriel L. Epstein (Univ. of California, Berkeley). Dr. Epstein's work is to observe and to analyze the atomic spectrum of the rare earth element, triply ionized lanthanum. To do this he will use the sliding spark source (a light source for exciting a spectrum) developed by J. Sugar of NBS. Work on La I, II, and III has been done by Bureau scientists. (J. Reader, adviser; Gaithersburg)

Benjamin F. Gibson (Stanford Univ.). In his investigations of nuclear structure, Dr. Gibson is looking into the structures of the ground state of the nucleus and also excited states. In a further study dealing with nuclear reactions, he hopes to derive reaction calculations that would add significantly to the testing and evaluation of models, such as those that have been developed recently to explain the electromagnetic properties of ^{4}He. (M. Danos, adviser; Gaithersburg)

Larry B. Handy (Univ. of Wisconsin). Dr. Handy's research in transition metal chemistry is directed toward obtaining information about the production and reactions of transition metal complexes under energetic conditions. Such detailed information is severely limited at present. (F. Brinckman, adviser; Gaithersburg)

Robert A. Hegstrom (Harvard Univ.). Dr. Hegstrom has proposed to investigate the behavior of the hydrogen atom in a magnetic field and to include the calculation of higher-order effects, which are usually ignored in a study of this type. Because of the fundamental importance in physics and chemistry of the g factors of the proton and electron, particular attention will be given to the change in these factors from their free-space values to the values they assume in the hydrogen atom. (J. H. Shirley, adviser; Boulder)

John W. Knoeck (Iowa State Univ.). Dr. Knoeck is conducting fundamental studies on the electrochemistry of the cerium system to help resolve some of the unexplained phenomena of that system. The information he obtains can also be applied to solving important analytical problems of a more practical nature. (J. K. Taylor, adviser; Gaithersburg)

Hassell M. Ledbetter (Univ. of Illinois). Dr. Ledbetter is attempting to answer the question, "Why is the morphology of martensite discontinuous with composition?" The problem is of practical importance in that both the morphology and the fine structure of martensite affect the hardness of steels. The problem is also of theoretical importance in that the upper and lower limits of application of the crystallographic theories of martensite have not been established. (R. P. Reed, adviser; Boulder)

William R. Ott (Univ. of Pittsburgh). The vacuum ultraviolet spectral region has in recent years assumed high importance because of the urgent needs of space and plasma physics. So far, basic atomic data for this spectral range, particularly accurate atomic transition probabilities, are very scarce. Dr. Ott's investigation of the transition probabilities of the prominent lines of oxygen in the vacuum ultraviolet is designed to clear up a rather large discrepancy (factor of 5) on the data existing for these transitions. (W. L. Wiese, adviser; Gaithersburg)

Stephen J. Pierce (Univ. of California, Santa Barbara). Dr. Pierce's studies in pure mathematics (linear algebra) deal with higher-degree symmetry classes of tensors and generalized matrix functions, about which little is known. (M. Newman, adviser; Gaithersburg)

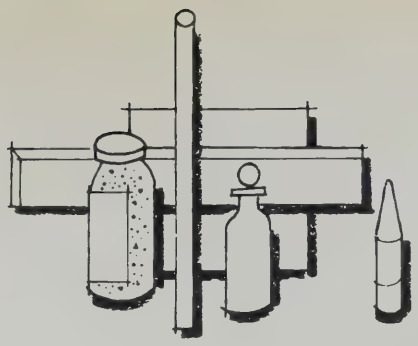
LeRoy W. Schroeder (Northwestern Univ.). Dr. Schroeder is seeking to increase his knowledge of the structure and dynamics of molecular crystals. In combination with the usual spectroscopic and structural techniques he is using two more recent techniques—inelastic neutron scattering and neutron diffraction. Such information can contribute to a better understanding of intermolecular forces in the solid state. (J. J. Rush, adviser; Gaithersburg)

Stuart K. Searles (Univ. of Alberta, Canada). Dr. Searles' proposed study will give an experimental base to gas phase ion-molecule reactions and their dependence on temperature. His work will add to the theory of these reactions and provide additional thermal energy rate constants. (P. Ausloos, adviser; Gaithersburg)

Stanley E. Stokowski (Stanford Univ.). Through studies of phase transitions in perovskites, Dr. Stokowski hopes to develop a theory that will describe the structural transitions commonly seen in these substances. Such a theory may lead to prediction and control of their properties. (L. H. Grabner, adviser; Gaithersburg)

Donald D. Thornton (Syracuse Univ.). Microwave resonance studies by Dr. Thornton in $FeCl_2 \cdot 4H_2O$ and similar materials will yield more information on the magnetic properties of matter, particularly the behavior of antiferromagnetic materials. These materials will be studied with normal microwave techniques at moderate magnetic fields. (B. W. Mangum, adviser; Gaithersburg).

STANDARD REFERENCE MATERIALS



Standard Reference Materials are well-characterized materials certified for chemical composition or for a particular physical or chemical property. These materials are disseminated by NBS to be used to calibrate and evaluate measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base.

Several new standard reference materials and the renewal of a low-carbon steel standard are now available from the NBS Office of Standard Reference Materials.[1] The new standards are binary alloys of the tungsten-molybdenum and gold-silver systems intended for quantative elemental microanalysis.

Tungsten-Molybdenum Microprobe Standard

This new standard reference material has been prepared for use in calibrating microprobe microanalyzers and is issued with a provisional certificate of analysis. Designated SRM 480, the standard is a composite consisting of a core of tungsten–20 weight percent molybdenum alloy wire (1 mm diameter) embedded in a pure molybdenum rod (5 mm diameter) onto which a layer of pure tungsten (1 mm thick) has been electroplated.

Material for the standard was prepared in the Lamp Metals and Components Department of the General Electric Company, Cleveland, Ohio, through the use of a powder metallurgy process using high-purity metal powders. Based on the results of about 1500 determinations for both tungsten and molybdenum by electron probe microanalysis, the material was found to be of high homogeneity approaching the micrometer level of spatial resolution.

Chemical analyses were performed on the W-Mo alloy by the NBS Analytical Chemistry Division (R. K. Bell and E. R. Deardorff) with the following values for the provisional certificate: Mo—21.5 weight percent, and W—78.5 weight percent.

Details of the preparation, testing, and intended use of this standard are described in NBS Spec. Publ. 260–16, *Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards IV: W–20 percent Mo Alloy Prepared by Powder Metallurgical Methods*, by Harvey Yakowitz, Robert E. Michaelis, and Donald L. Vieth (in press). SRM 480 should prove valuable to any microprobe laboratory doing quantitative analyses.

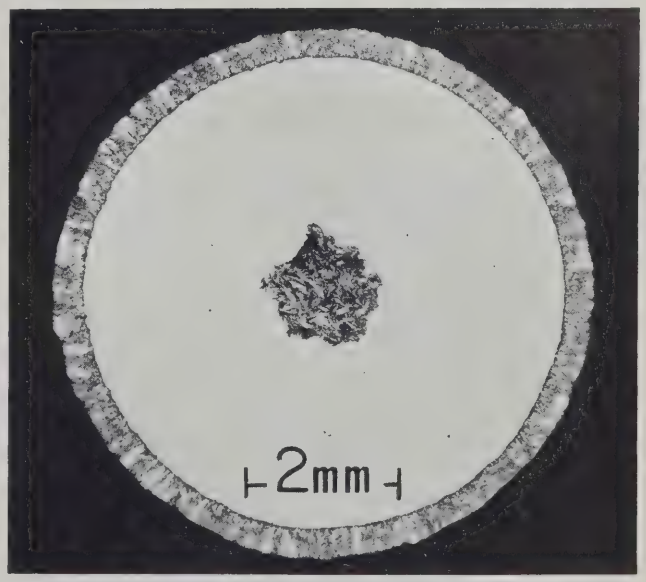
Supplied in wafers approximately 1 mm thick and 6 mm in diameter, SRM 480 costs $120 per unit.[2]

Gold-Silver Microanalytical Standards

The need for homogeneous and accurate standard reference materials for use in electron probe microanalysis has led to the preparation and characterization of binary alloys in the gold-silver system. As standards, these alloys should also prove highly useful in application to other microanalytical techniques such as laser beam spectrophotometry. Designated SRM 481, a set of these alloys is issued as a single standard. SRM 481 consists of a series of binary alloy wires that range in nominal composition from 100 percent gold to 100 percent silver by steps of 20 weight percent. The wires are 0.5 mm in diameter and 5 cm long, and have been color-coded for easy identification. A certificate of analysis issued with this standard gives the weight percent of both gold and silver as determined by chemical analysis in the NBS Analytical Chemistry Division (R. A. Durst).

Preparation and characterization of these alloys required several years of careful work. The material for the Au-Ag system was prepared by Cominco American,

continued



Overall view of SRM 480 showing the alloy wire at center encased in pure Mo (white) and pure W at the outer rim.

NORTHEAST CORRIDOR *continued*

asking some policy questions about it: What are its characteristics? Will it operate independently or tie in with existing modes? Is it an augmentation or variant of an existing mode? This appraisal is used to infer schedules, times, and costs for new or hypothetical modes used in the CORR models.

Use of CORR Model

The transportation system model simulates the traveler choosing among alternative modes of transportation and hence is employed by the researcher to investigate the consequence of change. Used with existing routes, it predicts travel on additional modes and the effect of changes in such things as toll charges, speed limits, and frequency of scheduled trips. The predictions are used by analysts in cost-benefit appraisals of change, in planning added modes or capacity, and in deciding where to place new modes. Some costs and benefits may not directly relate to the operation of a transportation system. One cost is displacement of residents for highway construction and a benefit is greater business volume resulting from improved access.

The application of the simulation technique is perhaps of greatest interest in attempting to answer long range questions: Will the private automobile be on the highways of 1980 in greater numbers than cars are now? Will airports then be as crowded as they are today? What volume will corridor-length, high-speed rail service carry? What slice of the market would be taken by VTOL (vertical takeoff and land) aircraft? Realistic answers to such questions are being sought at the Department of Transportation with the aid of models developed by NBS and other groups.

STANDARDS AND CALIBRATION *continued*

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0, and 15.0 MHz
WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. The pulses occur at intervals that are longer than one second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on February 1, 1969.*

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS–III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on February 1, 1969. The seconds pulses emitted from WWVB will be retarded 200 ms.*

STANDARD REFERENCE MATERIALS *continued*

Inc., using highly purified gold and silver. Thousands of individual electron probe analyses were performed using an automatic data-collecting device, especially constructed for this purpose, to assure that the homogeneity of these alloys would satisfy the requirements of the most critical analysts. In addition, a large amount of homogeneity testing was performed in the NBS Cryogenics Division Laboratory at Boulder, Colo., where residual resistivity ratios of R_{273K}/R_{4K} were determined.

A similar standard for the gold-copper system is in preparation and will be issued later this year. The gold-silver system, SRM 481, costs $73 per unit.[2]

Low-Carbon Steel Standard

This renewal standard, SRM 131b, is a low-carbon silicon steel certified for its carbon content only. Intended primarily for use in calibrating combustion carbon apparatus near the low end of the concentration scale, SRM 131b nominally contains 20 ppm by weight of carbon. Certification has been made by NBS on the basis of analyses performed at NBS and a number of cooperating laboratories. The material for the preparation of this standard was furnished by the Allegheny Ludlum Steel Corp., Brackenridge, Pa. Following conversion to chips at NBS and after careful mixing, the material was thoroughly tested and found satisfactory with respect to homogeneity.

Supplied in units of approximately 100 grams, this standard is priced at $22.

[1] For a complete list of standard reference materials available from NBS, see Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards, NBS Misc. Publ. 260 (1968 ed.) for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents. Quarterly insert sheets which update Misc. Publ. 260 are supplied to users on request.

[2] These standards may be purchased for the price indicated from the Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

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Technical News Bulletin, Volume 52, No. 12, December 1968, 30 cents. Annual subscription: Domestic, $3; foreign, $4. Available on a 1-, 2-, or 3-year subscription basis.

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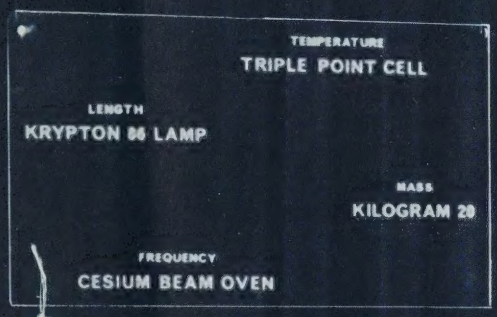
The Basic Four

All units of measurement in the International System—for mechanical, electrical, optical, thermal, radio, and other quantities—are ultimately derived from four basic prototype units: the meter of length, the kilogram of mass, the kelvin of temperature, and the second of time (see center insert). Shown here displayed in a vault at the National Bureau of Standards are the national standard of mass (Prototype Kilogram No. 20, under bell jars at right) and representative parts of the equipment used to realize the units for the other three basic quantities. These are (left to right) the krypton-86 lamp for length, the cesium-beam oven for time, and the triple-point cell for temperature.



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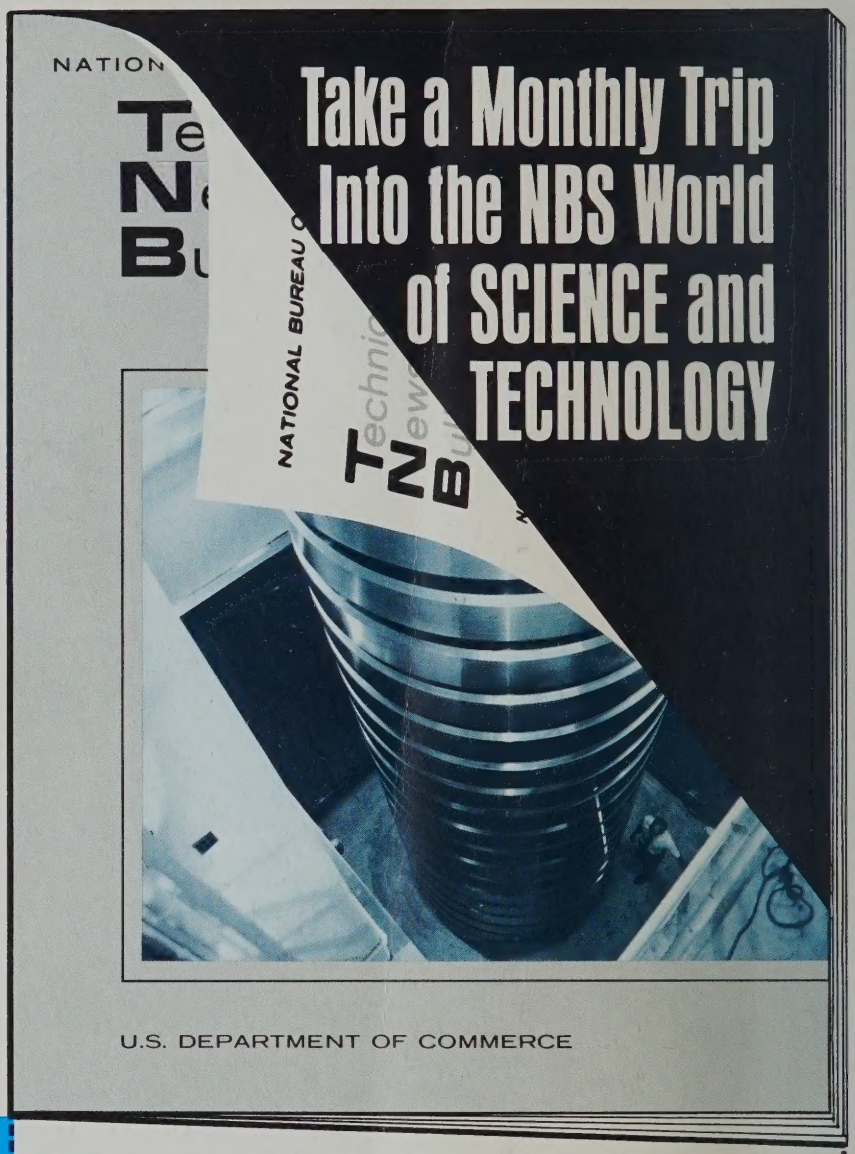

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